Duke Energy®

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July 19, 2006

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: Duke Power Company LLC d/b/a Duke Energy Carolinas, LLC (Duke)
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414
Licensee Event Report 413/06-001

Attached is Licensee Event Report 413/06-001 titled "Loss of Offsite Power Event Resulted in Reactor Trip of Both Catawba Units from 100% Power."

There are no regulatory commitments contained in this letter or its attachment.

This event is considered to be of no significance with respect to the health and safety of the public. If there are any questions on this report, please contact L.J. Rudy at (803) 831-3084.

Sincerely,

D.M. Jamil

Attachment

IE22

xc (with attachment):

W.D. Travers
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NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

# LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)



| 1. FACILITY NAME | 2. DOCKET NUMBER | 3. PAGE |
|---|---|---|
| Catawba Nuclear Station, Unit 1 | 05000 413 | 1 OF 14 |

**4. TITLE**

Loss of Offsite Power Event Resulted in Reactor Trip of Both Catawba Units from 100% Power

| 5. EVENT DATE MO | DAY | YEAR | 6. LER NUMBER YEAR | SEQUENTIAL NUMBER | REV NO | 7. REPORT DATE MO | DAY | YEAR | 8. OTHER FACILITIES INVOLVED FACILITY NAME | DOCKET NUMBER |
|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 20 | 2006 | 2006 | 001 | 00 | 07 | 19 | 2006 | Catawba Unit 2 | 05000414 |
| | | | | | | | | | FACILITY NAME | DOCKET NUMBER |

| 9. OPERATING MODE | 1 |
|---|---|
| 10. POWER LEVEL | 100% |

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20.2201(b) | | 20.2203(a)(3)(ii) | | 50.73(a)(2)(ii)(B) | | 50.73(a)(2)(ix)(A) |
| | 20.2201(d) | | 20.2203(a)(4) | | 50.73(a)(2)(iii) | | 50.73(a)(2)(x) |
| | 20.2203(a)(1) | | 50.36(c)(1)(i)(A) | X | 50.73(a)(2)(iv)(A) | | 73.71(a)(4) |
| | 20.2203(a)(2)(i) | | 50.36(c)(1)(ii)(A) | | 50.73(a)(2)(v)(A) | | 73.71(a)(5) |
| | 20.2203(a)(2)(ii) | | 50.36(c)(2) | | 50.73(a)(2)(v)(B) | | OTHER Specify in Abstract below or in NRC Form 366A |
| | 20.2203(a)(2)(iii) | | 50.46(a)(3)(ii) | | 50.73(a)(2)(v)(C) | | |
| | 20.2203(a)(2)(iv) | | 50.73(a)(2)(i)(A) | | 50.73(a)(2)(v)(D) | | |
| | 20.2203(a)(2)(v) | | 50.73(a)(2)(i)(B) | | 50.73(a)(2)(vii) | | |
| | 20.2203(a)(2)(vi) | | 50.73(a)(2)(i)(C) | | 50.73(a)(2)(viii)(A) | | |
| | 20.2203(a)(3)(i) | | 50.73(a)(2)(ii)(A) | | 50.73(a)(2)(viii)(B) | | |

**12. LICENSEE CONTACT FOR THIS LER**

| NAME | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| L.J. Rudy, Regulatory Compliance | 803-831-3084 |

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|---|---|---|---|---|---|---|---|---|---|
| B7i | FK | ICT | Moser-Glaser | Yes | | | | | |

| 14. SUPPLEMENTAL REPORT EXPECTED | | | 15. EXPECTED SUBMISSION DATE | MONTH | DAY | YEAR |
|---|---|---|---|---|---|---|
| YES (If yes, complete EXPECTED SUBMISSION DATE). | X | NO | | | | |

**16. ABSTRACT** (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On 05/20/06, at 1401 hours, both Catawba units tripped automatically from 100% power following a Loss of Offsite Power (LOOP) event. The event began when a fault occurred internal to a current transformer associated with one of the switchyard power circuit breakers. A second current transformer failure, along with the actuation of differential relaying associated with both switchyard busses, cleared both busses and separated the units from the grid. A Notification of Unusual Event (NOUE) was declared at 1414 hours. The Emergency Response Organization was electively activated. Both emergency diesel generators on each unit started automatically and supplied their required blackout and essential loads as designed. All three auxiliary feedwater pumps on each unit started automatically and fed the steam generators as designed. Decay heat was removed via natural circulation of the reactor coolant system, with steam relief through the steam generator power operated relief valves. Both units were stabilized in Mode 3 with cooldown activities in progress. Offsite power was restored to all 6900V busses on both units by 05/20/06 at 2041 hours. The NOUE was subsequently terminated on 05/21/06 at 0140 hours.

The root cause analysis for this event determined that in 1981, certain switchyard relay tap setting changes were not implemented at Catawba. Power Delivery documentation was subsequently erroneously updated to indicate that the changes had been made. Corrective actions for this event will include developing an enhanced process to ensure correct configuration management for the Catawba protective relay settings.

The health and safety of the public were not adversely affected by this event.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

BACKGROUND

This event is being reported under the following criterion:

10 CFR 50.73(a)(2)(iv)(A), any event or condition that resulted in manual or automatic actuation of the Reactor Protection System (RPS) including: reactor scram or reactor trip; PWR auxiliary or emergency feedwater system; and emergency ac electrical power systems, including: emergency diesel generators (EDGs).

Catawba Nuclear Station Units 1 and 2 each is a Westinghouse four-loop Pressurized Water Reactor (PWR) [EIIS: RCT].

The Catawba 230kV switchyard [EIIS: FK] is designed in a breaker-and-a-half scheme which allows any one of the switchyard power circuit breakers (PCB) [EIIS: 52] to be isolated from the grid without deenergizing any transmission line or affecting the integrity of the switchyard. Six double-circuit transmission lines from the primary transmission system terminate in the switchyard. Additionally, each Catawba unit is tied to the 230kV switchyard by two separate and independent overhead lines. The entire switchyard, including the power circuit breakers, cabling system, ac and dc auxiliary power systems, protective relaying system, and control system is also divided into two power trains. Additionally, the incoming transmission lines are also assigned to power trains in such a way as to separate the associated cabling, protective relaying, and controls for each circuit of the double-circuit transmission lines into two distinct sources of offsite power. The Catawba 230kV switchyard design assures the independence of the redundant offsite power feeders to each nuclear unit. Refer to Figure 1 for a visual depiction of the Catawba 230kV switchyard and offsite power arrangement.

The 4160VAC Essential Auxiliary Power System [EIIS: EB] supplies power to those Class 1E loads required to safely shut down the unit following a design basis accident. This system is divided into two completely redundant and independent trains, each consisting of one 4160V switchgear assembly, three 4160V/600V transformers, two 600V load centers, and associated loads. Normally, each Class 1E 4160V switchgear is powered from its associated non-Class 1E train of the 6900VAC Normal Auxiliary Power System [EIIS: EA]. Additionally, an alternate source of power to each 4160V essential switchgear is

EVENT DESCRIPTION

(Certain event times are approximate.)

| Date/Time | Event Description |
|---|---|
| 05/20/06/ Prior to event | Units 1 and 2 were operating in Mode 1 at 100% power. No activities were in progress that had any effect on the event. |
| 05/20/06/ 14:01:45.43 | A fault occurred internal to a current transformer associated with switchyard PCB-18 (Unit 1A bus tie breaker). The current transformer failure created a phase-to-ground fault on the associated "X" phase line. |
| 05/20/06/ 14:01:45.442 | Unit 1 transformer 1A differential protection relays actuated. |
| 05/20/06/ 14:01:45.459 | Unit 1 zone 1A lockout relay actuated. Signals were sent to trip PCB-17 and 18, generator breaker 1A, and switchyard yellow bus differential relay. |
| 05/20/06/ 14:01:45.461 | Unit 2 transformer 2B differential protective relays actuated. Unit 1 transformer 1B differential protective relays actuated. |
| 05/20/06/ 14:01:45.476 | Unit 2 zone 2B lockout relay actuated. Signals were sent to trip PCB-23 and 24, generator breaker 2B, and switchyard yellow bus differential relay. |
| 05/20/06/ 14:01:45.5 | Yellow bus differential protective relay actuated to clear the yellow bus ties. |

NARRATIVE (*If more space is required, use additional copies of NRC Form 366A*) (17)

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|---|---|
| | (1A, 1B, 2A, and 2B) started automatically and supplied all required blackout and essential loads. For each unit, both motor-driven auxiliary feedwater pumps and the turbine-driven auxiliary feedwater pump started automatically and fed the steam generators. |
| 05/20/06/14:14 | A NOUE was declared as a result of a LOOP to both units for more than 15 minutes. |
| 05/20/06/15:50 | The Technical Support Center Emergency Coordinator assumed the command and control function from the Operations Shift Manager and declared the Technical Support Center and the Operational Support Center activated. |
| 05/20/06/16:15 | The Technical Support Center notified the NRC Operations Center of the event (Event Number 42592). The required one-hour notification was made 61 minutes late. |
| 05/20/06/18:19 | The Emergency Operations Facility Director assumed the Emergency Coordinator function from the Technical Support Center and declared the Emergency Operations Facility activated. |
| 05/20/06/Evening | Both units were stabilized in Mode 3 with cooldown activities in progress. Decay heat was removed via natural circulation in the reactor coolant system, with secondary steam relieved through the steam generator power operated relief valves. |
| 05/20/06/20:28 | All Unit 2 6900V busses were reenergized. |
| 05/20/06/20:41 | All Unit 1 6900V busses were reenergized. |
| 05/20/06/23:03 | 4160V essential bus 1ETB was aligned to offsite power. |
| 05/20/06/23:31 | 4160V essential bus 2ETA was aligned to offsite power. |

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

| | |
|---|---|
| 05/20/06/23:54 | 4160V essential bus 2ETB was aligned to offsite power. |
| 05/21/06/00:00 | Both units exited LCO 3.0.3. |
| 05/21/06/01:11 | 4160V essential bus 1ETA was aligned to offsite power. |
| 05/21/06/01:40 | The NOUE was terminated. |
| 05/21/06/02:27 | The Technical Support Center and the Operational Support Center were deactivated. Emergency Response Organization personnel were released from duty and the Unit Recovery Team was staffed. |

CAUSAL FACTORS

This event was initiated as a result of the PCB-18 current transformer "X" phase ground fault. The exact cause of the ground fault is still under investigation. In addition, while the event was in progress, the PCB-23 "Y" phase current transformer also failed, which contributed to the LOOP. The exact cause of this failure is also still under investigation. When the investigations are complete, Catawba will evaluate whether a supplement to this LER is necessary; if a supplement is warranted, it will be submitted to the NRC.

During the investigation of this event, it was discovered that the red bus differential relays were inadequately set, which resulted in the red bus tripping inappropriately. This, in conjunction with the PCB-18 current transformer "X" phase ground fault and the failure of the PCB-23 "Y" phase current transformer, caused all four bus lines from the two units to isolate. This resulted in the loss of all offsite power to the units. The root cause analysis for this event determined that in 1981, tap setting changes for the yellow and red bus differential protective relays to account for load growth were not implemented at Catawba. Power Delivery documentation was subsequently erroneously updated to indicate that the changes had been made.

If the actual relay settings in the switchyard had been set adequately, the event would have been limited to the actuation of main step-up transformer 1A differential protective relaying and the yellow bus differential protective relaying in response to the fault on the "X" phase of the PCB-18 current transformer. Actuation of the main step-up transformer 2B differential protective relaying would have occurred in response to the fault on the "Y" phase of the PCB-23 current transformer. Both units would have run back to 48% main generator electrical output. In combination with the number of transmission lines available, the switchyard design should have prevented the LOOP on Units 1 and 2.

CORRECTIVE ACTIONS

Immediate:

1. Plant operators stabilized both units following the reactor trips.

Subsequent:

1. The Emergency Response Organization directed the overall response to the LOOP event following the declaration of the NOUE.

2. Once all four essential busses were aligned to offsite power, the NOUE was terminated.

3. The red and yellow switchyard bus differential protective relays were adequately set and tested.

4. The PCB-18 "X" phase and PCB-23 "Y" phase current transformers were replaced.

Planned:

1. Catawba will confirm that all Power Delivery controlled Catawba protective relays are set as designed and will verify configuration management.

2. An enhanced process will be developed to ensure correct configuration management for the Catawba protective relay settings.

NARRATIVE (*If more space is required, use additional copies of NRC Form 366A*) (17)

3. The investigations of the failures of the PCB-18 "X" phase and PCB-23 "Y" phase current transformers will be completed and associated corrective actions will be implemented.

There are no NRC commitments contained in this LER.

SAFETY ANALYSIS

Following the LOOP, both units experienced a reactor trip from 100% power. Unit 1 tripped on a nuclear instrumentation power range high positive flux rate signal. This was not an expected response, as there was no actual increase in power as a result of the LOOP. There were no adverse effects from tripping on high flux rate for this event. Given the severity of the switchyard transient, a reactor trip was inevitable. The unexpected trip on high flux rate was entered into the station's corrective action program for further evaluation and corrective action as necessary. Unit 2 tripped on a reactor coolant pump bus underfrequency signal. Subsequent evaluation and comparison to the Catawba Unit 2 LOOP event in 1996 resulted in the determination that an underfrequency trip signal will occur in an undervoltage situation due to an undervoltage detection circuit within the underfrequency monitor. For both units, the reactor trip breakers opened and the control rods inserted within their required times. The Unit 1 and Unit 2 main turbines tripped within their required times following their respective reactor trips.

Following the LOOP, all four reactor coolant pumps for each unit tripped and natural circulation conditions were established in each unit's reactor coolant system.

A main feedwater isolation signal was generated for both units as a result of the reactor trip with low $T_{ave}$ (564°F) signal. All valves associated with the main feedwater isolation closed within the required time frame for both units.

Because pressurizer spray from the reactor coolant pumps was unavailable following the LOOP, primary pressure relief occurred via the pressurizer Power Operated Relief Valves (PORVs). For Unit 1, PORVs NC-32B and NC-34A cycled to control pressurizer pressure. For Unit 2, PORV NC-34A cycled to control pressurizer pressure. For both units, the pressurizer code safety relief valves were not challenged. During the transient, the Unit 1 Train B pressurizer heaters did not

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

energize as expected due to a blown control circuit fuse. The fuse was subsequently replaced.

Reactor coolant system letdown flow was automatically secured as a result of low pressurizer level. The low level was due to shrinkage in the reactor coolant system associated with the cooldown following the reactor trip. Abnormal and emergency procedures were implemented to restore letdown to service.

Both main feedwater pumps for each unit tripped on low-low suction pressure due to the loss of all hotwell and condensate booster pumps following the LOOP.

Both emergency diesel generators for each unit started as designed and supplied power to their required blackout and essential loads. In addition, both motor-driven auxiliary feedwater pumps and the turbine-driven auxiliary feedwater pump for each unit started as designed and fed the steam generators. Secondary heat removal occurred via the steam generator PORVs, as the steam dump to condenser function was unavailable due to the loss of power. For both units, the main steam code safety relief valves were not challenged. Each unit experienced a main steam isolation on low steamline pressure as steam generator pressures decreased to the actuation setpoint of 775 psig. The pressure decrease resulted principally from steam use by secondary plant systems and relatively cool auxiliary feedwater being fed to the steam generators.

During the event, it was observed that the selected Train A control room area chilled water system chiller did not automatically restart once the signal from the load sequencer was received. The chiller was manually started. The failure was subsequently determined to be due to a loose wire on the program timer within the chiller control panel. The issue was subsequently resolved.

A risk assessment of this event determined that the Conditional Core Damage Probability (CCDP) associated with this event is > 1E-6 for both Units 1 and 2. The Conditional Large Early Release Probability (CLERP) associated with this event is > 1E-7 for both Units 1 and 2. Therefore, this event represents an accident sequence precursor.

Although a dual unit LOOP event has not been explicitly evaluated in Updated Final Safety Analysis Report (UFSAR) Chapter 15, the UFSAR does discuss, for a single unit, a complete loss of non-emergency AC power to the station auxiliaries (UFSAR Section 15.2.6). The primary concerns for this event are: (1) short-term core cooling capability, (2) primary system overpressurization, (3) secondary system overpressurization, and (4) long-term core cooling capability.

(1) The short-term transient core power response for this event, and consequently the short-term core cooling capability, is bounded by the complete loss of flow event (UFSAR Section 15.3.2) due to the timing associated with the insertion of the control rods. In the complete loss of flow event, the reactor trips when the reactor coolant pump bus undervoltage setpoint is reached, and the control rods begin to fall into the core after an instrumentation delay. In the loss of non-emergency AC power transient, the control rods begin to fall immediately due to the loss of gripper coil voltage.

(2) Similar to the short-term cooling capability, the primary system temperature response increases for this event. Therefore, the peak primary system pressure for this event is also bounded by the complete loss of flow event (again, due to the timing associated with the insertion of the control rods).

(3) The peak secondary pressure response for this event is bounded by the turbine trip event (UFSAR Section 15.2.3), again due to the timing of the insertion of control rods. For the loss of non-emergency AC power transient, the control rods begin to fall immediately due to the loss of gripper coil voltage well before the turbine trips, such that the primary system heat generation is rapidly decreasing as secondary side pressure is increasing. Secondary side pressure does not rise significantly until the turbine trips and steam flow is terminated. Since the magnitude of the secondary side pressure increase is largely determined by the amount of heat transferred from the primary system to the secondary system, the turbine trip event bounds this event because the control rods have not fallen at the time of the turbine trip. In addition, the turbine trip event analyzed in UFSAR Section 15.2.3 conservatively assumes the reactor does not trip on the turbine trip signal, meaning the control rods do not insert until well after the turbine trips.

(4) The long-term core cooling capability for this event is shown in UFSAR Section 15.2.6 by analyzing the transition from forced flow to natural circulation following a loss of non-emergency AC power. UFSAR Section 15.2.6 presents the Catawba Unit 2 Model D5 steam generator analysis, which is performed such that the results bound the feedring

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

steam generators in Catawba Unit 1. The long-term transient response for both units remained within the bounds of the LOOP event as analyzed in UFSAR Section 15.2.6.

Based on the above, the transient response for both units remained within the bounds of UFSAR Chapter 15.

Finally, as a result of this event, Catawba's compliance with 10 CFR 50, Appendix A, General Design Criterion 17 (Electric Power Systems) was evaluated. The evaluation determined that the design of Catawba's power systems meets the requirements of this criterion. The loss of offsite power during this event resulted from the inadequately set relays associated with the red bus. In the absence of this implementation issue, both units would have remained connected to offsite power sources.

The health and safety of the public were not adversely affected by this event.

ADDITIONAL INFORMATION

As noted in the Event Description, the initial notification to the NRC Operations Center was made 61 minutes late. This delay was a matter of established priority and Senior Reactor Operator (SRO) availability in the control room. The SROs normally available to make the NRC notification were tasked with plant recovery and procedure implementation responsibilities. The offsite agency communicator, who was a non-licensed operator, could have been tasked to make the NRC notification, but he was engaged in contacting the local offsite emergency management agencies. This process was delayed in part due to the loss of fax capability, requiring the reading of notification forms to the agencies. Also contributing to the delay was the inability to contact one of the agencies during the initial notification. By the time the initial notification was completed to all agencies, a one-hour followup notification was required. This fully occupied the offsite agency communicator's time past the first hour of the event. He was not redirected to make the NRC notification. The late notification of the event was entered into the station's corrective action program.

Within the last three years, there were no LER events involving a LOOP or a loss of power to an essential bus. Also, within the last three years, there were no LER events involving a reactor trip caused by

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changes not being adequately communicated or by personnel/department interactions not being considered. Therefore, this event was determined to be non-recurring in nature.

Energy Industry Identification System (EIIS) codes are identified in the text as [EIIS: XX]. This event is considered reportable to the Equipment Performance and Information Exchange (EPIX) program.

This event is not considered to be a Safety System Functional Failure. There were no releases of radioactive materials, radiation exposures, or personnel injuries associated with this event.

| FACILITY NAME (1) | DOCKET (2) NUMBER (2) | LER NUMBER (6) YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | PAGE (3) |
|---|---|---|---|---|---|
| Catawba Nuclear Station, Unit 1 | 05000413 | 2006 | - 001 - | 00 | 14 OF 14 |

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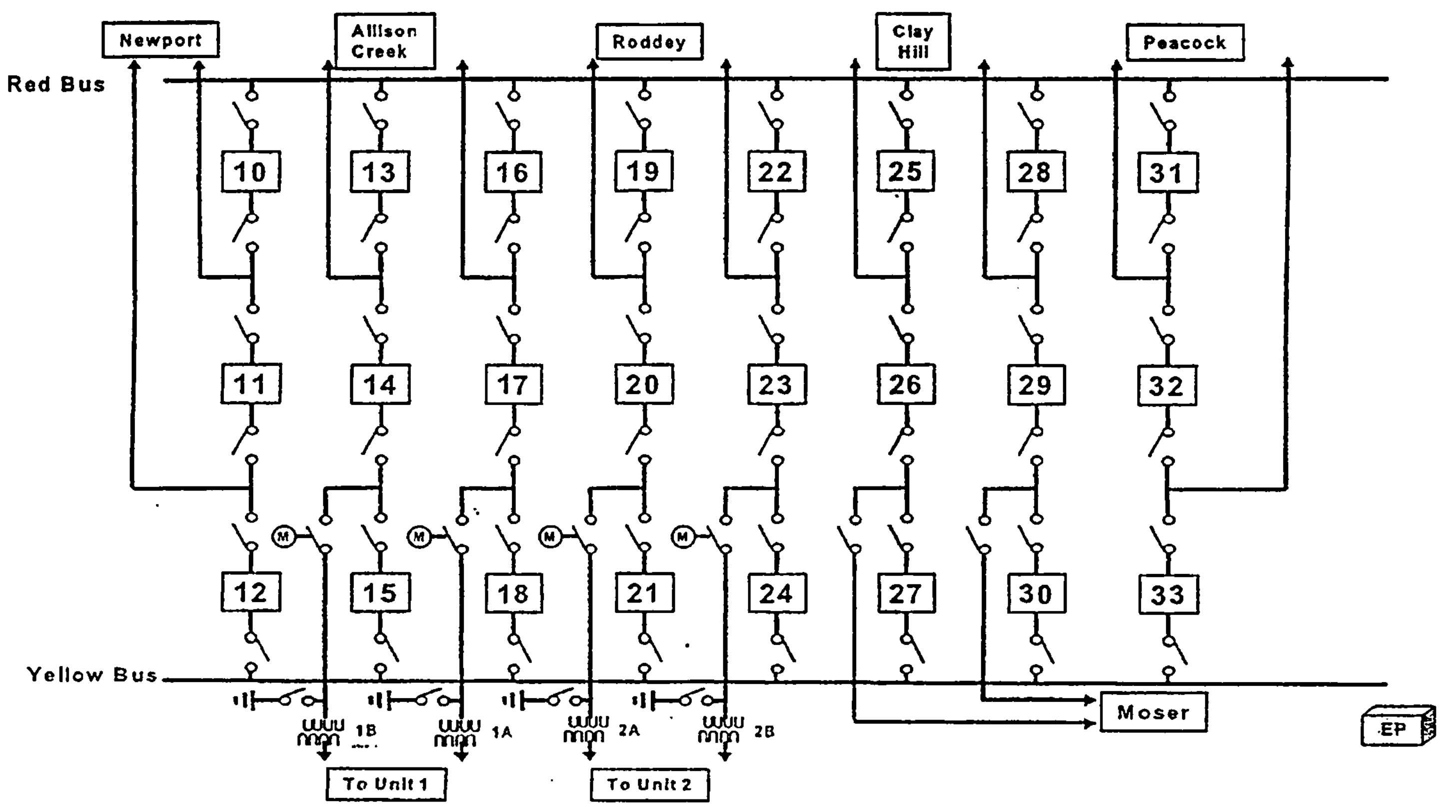
Figure 1




230 KV Switchyard